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L28	(5619700 | 5438661 | 5357631 | 5159669 | 5546528)![PN]	10	L28
L27	('5757372')[PN]	2	L27
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L25	('5890181')[PN]	2	L25
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L24	5706506.pn.	1	L24
DB=PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD; PLUR=YES; OP=OR			
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L22	L21 and (undo with step or backward with step or redo with step or forward with step)	494	L22
L21	(document near states or document with states or document adj states)	16703	L21
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L16	345/819	35	L16
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L4	715/530	505	L4
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L1	707/101	3880	L1

END OF SEARCH HISTORY

A selective undo mechanism for graphical user interfaces based on command objects

Author   Thomas Berlage German National Research Center for Computer Science, Sankt Augustin, Germany

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↑ ABSTRACT

It is important to provide a recovery operation for applications with a graphical user interface. A restricted linear undo mechanism can conveniently be implemented using object-oriented techniques. Although linear undo provides an arbitrarily long history, it is not possible to undo isolated commands from the history without undoing all following commands. Various undo models have been proposed to overcome this limitation, but they all ignore the problem that in graphical user interfaces a previous user action might not have a sensible interpretation in another state. Selective undo introduced here can undo isolated commands by copying them into the current state "if that is meaningful." Furthermore, the semantics of selective undo are argued to be more natural for the user, because the mechanism only looks at the command to undo and the current state and does not depend on the history in between. The user interface for selective undo can also be implemented generically. Such a generic implementation is able to provide a consistent recovery mechanism in arbitrary applications.

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Note: OCR errors may be found in this Reference List extracted from the full text article. ACM has opted to expose the complete List rather than only correct and linked references.

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↑ INDEX TERMS

Primary Classification:
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      ↳ **Subjects:** User interfaces

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    ↳ **H.5.2** User Interfaces (D.2.2, H.1.2, I.3.6)
      ↳ **Subjects:** Interaction styles (e.g., commands, menus, forms, direct manipulation); User interface management systems (UIMS)
    ↳ **H.5.3** Group and Organization Interfaces
      ↳ **Subjects:** Synchronous interaction

General Terms:
Design, Human Factors

Keywords:
command objects, groupware, undo

↑ REVIEW

"Michael Lee Gordon"

Various undo mechanisms for graphical user interfaces are reviewed. The author proposes a selective undo mechanism that, according to him, can overcome the limitations of the traditional linear undo mechanisms. Berlage provides an informative review of popular undo models, focusing

on the incompatibilities between the linear undo model, where actions can be undone by, in effect, rewinding and backing out each operation that is recorded, and the graphical user interface, where people can directly manipulate objects and are not limited to command histories. Berlage describes a selective undo model that looks at both the command to undo and the current state and does not depend on the history in between. The author is reporting on work in progress. He admits that there are problems to be worked through, but Berlage proposes the selective undo model as a new recovery mechanism that can be used generically in an application framework. *Online Computing Reviews Service*

↑ **Collaborative Colleagues:**

Thomas Berlage: Uwe Behrens　　　F. Ulrich
　　　　　　　　Christian Beilken　Peter Wißkirchen
　　　　　　　　Andreas Genau
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1 A selective undo mechanism for graphical user interfaces based on command objects   ▩
Thomas Berlage
September 1994 **ACM Transactions on Computer-Human Interaction (TOCHI)**, Volume 1
Issue 3
Full text available: 🔖 pdf(1.78 MB)   Additional Information: full citation, abstract, references, citings, index terms, review

It is important to provide a recovery operation for applications with a graphical user interface. A restricted linear undo mechanism can conveniently be implemented using object-oriented techniques. Although linear undo provides an arbitrarily long history, it is not possible to undo isolated commands from the history without undoing all following commands. Various undo models have been proposed to overcome this limitation, but they all ignore the problem that in graphical user interfaces a ...

Keywords: command objects, groupware, undo

2 A framework for undoing actions in collaborative systems   ▩
Atul Prakash, Michael J. Knister
December 1994 **ACM Transactions on Computer-Human Interaction (TOCHI)**, Volume 1
Issue 4
Full text available: 🔖 pdf(2.54 MB)   Additional Information: full citation, abstract, references, citings, index terms

The ability to undo operations is a standard feature in most single-user interactive applications. We propose a general framework for implementing undo in collaborative systems. The framework allows users to reverse their own changes individually, taking into account the possibility of conflicts between different users' operations that may prevent an undo. The proposed framework has been incorporated into DistEdit, a toolkit for building group text editors. Based on our experience with Dist ...

Keywords: DistEdit, computer-supported cooperative work, concurrency control, groupware, selective undo, state recovery, undo, user recovery

3 Undoing actions in collaborative work   ▩
Atul Prakash, Michael J. Knister
December 1992 **Proceedings of the 1992 ACM conference on Computer-supported cooperative work**
Full text available: 🔖 pdf(846.89 KB)   Additional Information: full citation, references, citings, index terms

Keywords: collaboration, conflict analysis, groupware, undo

4 A temporal model for multi-level undo and redo
   W. Keith Edwards, Takeo Igarashi, Anthony LaMarca, Elizabeth D. Mynatt
   November 2000 **Proceedings of the 13th annual ACM symposium on User interface
                    software and technology**
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   Keywords: Flatland, Timewarp, history management, redo, timelines, undo

5 Research papers: streams: Fault-tolerance in the Borealis distributed stream
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   Magdalena Balazinska, Hari Balakrishnan, Samuel Madden, Michael Stonebraker
   June 2005 **Proceedings of the 2005 ACM SIGMOD international conference on
              Management of data**
   Full text available: pdf(612.50 KB)   Additional Information: full citation, abstract, references

   We present a replication-based approach to fault-tolerant distributed stream processing in
   the face of node failures, network failures, and network partitions. Our approach aims to
   reduce the degree of inconsistency in the system while guaranteeing that available inputs
   capable of being processed are processed within a specified time threshold. This threshold
   allows a user to trade availability for consistency: a larger time threshold decreases
   availability but limits inconsistency, while a smal ...

6 Undo as concurrent inverse in group editors
   Chengzheng Sun
   December 2002 **ACM Transactions on Computer-Human Interaction (TOCHI)**, Volume 9
                 Issue 4
   Full text available: pdf(814.03 KB)   Additional Information: full citation, abstract, references, citings, index
                                                                   terms

   As an important mechanism for error recovery and exploration of alternatives in interactive
   and collaborative applications, an undo facility should have the capability of undoing any
   operation at any time. However, supporting undo in collaborative applications is technically
   challenging and none of the existing group undo solutions is able to offer such a capability.
   In this article, we contribute an undo solution with such a capability for group text editors.
   The basic idea is to interpret an u ...

   Keywords: Group undo, REDUCE, collaborative applications, computer-supported
   cooperative work, concurrency control, consistence maintenance, distributed systems,
   operational transformation

7 A framework for shared applications with a replicated architecture
   Thomas Berlage, Andreas Genau
   December 1993 **Proceedings of the 6th annual ACM symposium on User interface
                    software and technology**
   Full text available: pdf(984.32 KB)   Additional Information: full citation, references, citings, index terms

   Keywords: application framework, command objects, computer-supported cooperative
   work, history tree, selective undo and redo, user interface management system

8 Undo any operation at any time in group editors

Chengzheng Sun
December 2000 **Proceedings of the 2000 ACM conference on Computer supported cooperative work**

Full text available: pdf(183.08 KB)   Additional Information: full citation, abstract, references, citings, index terms

The ability to undo operations is an indispensable feature of real-time group editors, but supporting group undo is a difficult problem. None of the existing solutions for group undo is able to support undoing any operation at any time with guaranteed success. In this paper, we contribute a novel group undo solution with such a capability. The basic idea is to interpret an undo command as a concurrent inverse operation by means of operational transformation, so that an operation is always ...

Keywords: distributed computing, group editors, group undo, groupware, operational transformation

9 Variation in element and action: supporting simultaneous development of alternative solutions
Michael Terry, Elizabeth D. Mynatt, Kumiyo Nakakoji, Yasuhiro Yamamoto
April 2004 **Proceedings of the SIGCHI conference on Human factors in computing systems**

Full text available: pdf(409.98 KB)   Additional Information: full citation, abstract, references, citings, index terms

The complexity of many problems necessitates creating and exploring multiple, alternative solutions. However, current user interfaces do not cleanly support creating alternatives at a time when they are likely to be discovered: as users interactively modify data. This paper presents Parallel Paths, a novel model of interaction that facilitates generating, manipulating, and comparing alternative solutions. In contrast to existing approaches such as automated history capture tools, Parallel Paths ...

Keywords: experimentation, exploration, interaction models, parallel exploration, what-if tools

10 Data exploration across temporal contexts
Mark Derthick, Steven F. Roth
January 2000 **Proceedings of the 5th international conference on Intelligent user interfaces**

Full text available: pdf(1.48 MB)   Additional Information: full citation, abstract, references, citings, index terms

The ability to quickly explore and compare multiple scenarios is an important component of exploratory data analysis. Yet today's interfaces cannot represent alternative exploration paths as a branching history, forcing the user to recognize conceptual branch points in a linear history. Further, the interface can only show information from one state at a time, forcing the user to use her memory to compare scenarios. Our system includes a tree-structured visualization for navigati ...

Keywords: context, exploratory data analysis, undo

11 Achieving convergence, causality preservation, and intention preservation in real-time cooperative editing systems
Chengzheng Sun, Xiaohua Jia, Yanchun Zhang, Yun Yang, David Chen
March 1998 **ACM Transactions on Computer-Human Interaction (TOCHI)**, Volume 5 Issue 1

Full text available: pdf(273.05 KB)   Additional Information: full citation, abstract, references, citings, index terms

Real-time cooperative editing systems allow multiple users to view and edit the same

text/graphic/image/multimedia document at the same time for multiple sites connected by communication networks. Consistency maintenance is one of the most significant challenges in designing and implementing real-time cooperative editing systems. In this article, a consistency model, with properties of convergence, causality preservation, and intention preservation, is proposed as a framework for consistenc ...

Keywords: REDUCE, causality preservation, computer-supported cooperative work, consistency maintenance, convergence, cooperative editing, groupware systems, intention preservation, operational transformation

12 Recognizing creative needs in user interface design
Michael Terry, Elizabeth D. Mynatt
October 2002 **Proceedings of the 4th conference on Creativity & cognition**

Full text available: pdf(478.46 KB)   Additional Information: full citation, abstract, references, citings, index terms

The creative process requires experimentation, the exploration of variations, and the continual evaluation of one's progress. While these processes are frequently non-linear and iterative, modern user interfaces do not explicitly support these practices, and instead impose a linear progression through tasks that is a poor fit for creative pursuits. In this paper we use data from three case studies, and draw upon Sch$#246;n's theory of reflection-in-action to illustrate specific deficiencies in c ...

Keywords: creativity, image manipulation, non-linear interaction model, on-demand previews, open-ended tasks, side view

13 The implementation of Etude, an integrated and interactive document production system
Michael Hammer, Richard Ilson, Tim Anderson, Edward Gilbert, Michael Good, Bahram Niamir, Larry Rosentein, Sandor Schoichet
June 1981 **ACM SIGPLAN Notices , Proceedings of the ACM SIGPLAN SIGOA symposium on Text manipulation**, Volume 16 Issue 6

Full text available: pdf(1.03 MB)   Additional Information: full citation, abstract, references, citings, index terms

Etude is an experimental text processing system that is being developed in order to formulate and evaluate new approaches to the design of user interfaces for office automation tools. The primary design goal for Etude is to provide the user with substantial functionality in the editing and formatting of documents in the context of a system that is easy to learn and use.

14 A generic operation transformation scheme for consistency maintenance in real-time cooperative editing systems
Chengzheng Sun, Yanchun Zhang, Xiahua Jia, Yun Yang
November 1997 **Proceedings of the international ACM SIGGROUP conference on Supporting group work: the integration challenge**

Full text available: pdf(1.55 MB)   Additional Information: full citation, references, citings, index terms

Keywords: CSCW, consistency maintenance, cooperative editing, distributed computing, intention preservation

15 ARIES: a transaction recovery method supporting fine-granularity locking and partial rollbacks using write-ahead logging
C. Mohan, Don Haderle, Bruce Lindsay, Hamid Pirahesh, Peter Schwarz
March 1992 **ACM Transactions on Database Systems (TODS)**, Volume 17 Issue 1

Full text available: pdf(5.23 MB)   Additional Information: full citation, abstract, references, citings, index terms, review

DB2TM, IMS, and TandemTM systems. ARIES is applicable not only to database management systems but also to persistent object-oriented languages, recoverable file systems and transaction-based operating systems. ARIES has been implemented, to varying degrees, in IBM's OS/2TM Extended Edition Database Manager, DB2, Workstation Data Save Facility/VM, Starburst and QuickSilver, and in the University of Wisconsin's EXODUS and Gamma d ...

Keywords: buffer management, latching, locking, space management, write-ahead logging

16 On handling component and transaction failures in multi agent systems

Pradeep Reddy Varakantham, Santosh Kumar Gangwani, Kamalakar Karlapalem
December 2001 **ACM SIGecom Exchanges**, Volume 3 Issue 1

Full text available: pdf(93.91 KB)   Additional Information: full citation, abstract, references, index terms

Multi agent systems are being used for various practical applications like e-commerce, e-auctions and gathering information from the web. Thus there is a need for these systems to be robust. However, agents can fail due to component failures. The atomic tasks taken up by the agents might also fail. So, agents need to recover to a correct state after a failure. This paper deals with the logging required and hence forth the recovery protocol to recover the agent to a correct state. An agent is mod ...

Keywords: agent, atomicity in agents, durability in agents, logging in agents, multi agent system, recovery in agents

17 From undo to multi-user applications: the demo

Michael Spenke
May 1993 **Proceedings of the SIGCHI conference on Human factors in computing systems**

Full text available: pdf(256.22 KB)   Additional Information: full citation, abstract, references, citings, index terms

The object-oriented history mechanism of the GINA application framework and its relevance for multi-user applications are demonstrated. The interaction history of a document is represented as a tree of command objects. Synchronous cooperation is supported by replicating the document state and exchanging command objects. Asynchronous cooperation leads to different branches of the history tree which can later be merged.

Keywords: CSCW, command objects, dialog history, management systems, undo, user interface

18 US&R: A new framework for redoing (Extended Abstract)

Jeffrey Scott Vitter
April 1984 **Proceedings of the first ACM SIGSOFT/SIGPLAN software engineering symposium on Practical software development environments**, Volume 19 , 9 Issue 5 , 3

Full text available: pdf(916.36 KB)   Additional Information: full citation, abstract, references, citings, index terms

US&R (which stands for Undo, Skip, & Redo) is a new interactive approach to user recovery that offers significant advantages over current Undo/Redo packages. In the US&R package, a SKIP or REDO command may be ambiguous, in which case US&R enumerates the logical interpretations of the command and prompts the user both textually and graphically for the desired choice. US&R also allows new commands to be executed during the redo process. With US&R, novi ...

19 Semantic pointing: improving target acquisition with control-display ratio adaptation

Renaud Blanch, Yves Guiard, Michel Beaudouin-Lafon

April 2004 **Proceedings of the SIGCHI conference on Human factors in computing systems**

Full text available: pdf(543.47 KB)   Additional Information: full citation, abstract, references, citings, index terms

We introduce semantic pointing, a novel interaction technique that improves target acquisition in graphical user interfaces (GUIs). Semantic pointing uses two independent sizes for each potential target presented to the user: one size in motor space adapted to its importance for the manipulation, and one size in visual space adapted to the amount of information it conveys. This decoupling between visual and motor size is achieved by changing the control-to-display ratio according to cursor dista ...

Keywords: Fitts' law, control-display ratio, graphical user interface, pointing, semantic pointing

20 Operational transformation: Grouping in collaborative graphical editors

Claudia-Lavinia Ignat, Moira C. Norrie

November 2004 **Proceedings of the 2004 ACM conference on Computer supported cooperative work**

Full text available: pdf(212.15 KB)   Additional Information: full citation, abstract, references, index terms

Often collaborative graphical systems lag behind well accepted single-user applications in terms of features supported. The frequently used operations of group/ungroup offered by almost every single-user graphical editor have not been considered by the collaborative graphical editing systems that try to preserve the intentions of the users involved in the concurrent editing. In this paper we present a novel algorithm based on operation serialisation for consistency maintenance in collaborativ ...

Keywords: collaborative graphical editors, consistency, grouping/ungrouping, maintenance, serialisation

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From Undo to Multi-User Applications — the Demo

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ABSTRACT

The object-oriented history mechanism of the GINA application framework and its relevance for multi-user applications are demonstrated. The interaction history of a document is represented as a tree of command objects. Synchronous cooperation is supported by replicating the document state and exchanging command objects. Asynchronous cooperation leads to different branches of the history tree which can later be merged.

KEYWORDS: User Interface Management Systems, CSCW, Command Objects, Undo, Dialog History.

INTRODUCTION

GINA (the Generic INteractive Application) is a class library which allows the implementation of state-of-the-art direct-manipulation user interfaces [7]. Applications are created by defining subclasses of GINA classes and adding and overriding methods. The behaviour of a typical application is inherited in this way. The unlimited history mechanism is generically implemented in GINA and therefore available in all applications. It is based on command objects describing user actions and the resulting state transitions of a graphical-interactive application.

The history mechanism was originally developed to implement a flexible undo/redo facility and to store the complete dialog history together with a document so that all steps necessary to create the document can later be demonstrated in an animated replay ("interaction recorder"). However, it turned out that command objects are also ideally suited to implement multi-user applications with a replicated architecture: After each user action, the resulting command object is broadcast to all other sites to maintain both an identical document state and a common dialog history.

Each command object is marked with a vector timestamp of a virtual time mechanism [3,4], so that conflicts due to concurrently executed commands are detected. In order to resolve such conflicts, undo and redo operations are

automatically performed to rearrange the commands into a linear order.

Furthermore, users can easily switch to asynchronous cooperation where exchanging commands is stopped and separate dialog histories are generated. Later on, the histories can be merged using the redo mechanism, leading again to a common document state. Often, this merging can be performed completely automatically, however, sometimes conflicts between commands of different users must be resolved interactively.

The ability to undo arbitrary isolated commands of the dialog history ("selective undo") is especially important for multi-user applications: Normally, the last command submitted by a certain user is to be undone, which is not necessarily the last command in the global history, because other users may have performed further commands in the meantime [6].

The amount of coupling between the interfaces in a distributed session can be varied by specifying which kinds of commands are broadcast to other participants. Users can decide to exchange only state-changing commands or to exchange commands for browsing, scrolling and object selection as well. Finally, in the tightly coupled mode, the feedback during command specification (dragging objects, pulling down menus) is also immediately transmitted.

The interaction recorder, i.e. the ability to perform an animated replay of the past, is also of special importance in distributed sessions, because users can easily miss something happening on their screens when they are absent or distracted for a moment.

GINA has been implemented in Common Lisp/CLOS and is based on OSF/Motif. It is freely distributed, and the currently released version contains the unlimited linear history mechanism. Recent extensions include selective undo, the interaction recorder [1] and support for multi-user applications [2]. This work is part of the development of a distributed shared work environment based on the metaphor of a virtual office building where users can meet, communicate, and cooperate.

DEMO OVERVIEW

First, some of the standard GINA demo applications are shown to illustrate the general concepts of GINA and the unlimited undo/redo mechanism. Next, the interaction recorder is demonstrated in the context of a simple

graphical editor. User interactions such as dragging objects, selecting from menus, and operating dialog boxes are recorded and can be replayed and animated.

In the main part of the demo, different forms of cooperation in a multi-user spreadsheet are demonstrated in relatively realistic scenarios. This example was chosen because recent studies [5] have shown that spreadsheet co-development is the rule, not the exception. It is assumed, but not demonstrated, that users can communicate at least over an audio connection during the session.

In the first scenario, members of a group negotiate about the distribution of a budget. The requirements of each participant are entered in separate areas of the sheet. In this phase the user interfaces are loosely coupled, i.e. each participant independently works in a different section of the sheet, but cell entries are kept consistent. Later on, in the negotiation phase, the interfaces are tightly coupled, and modifications are performed in close cooperation of the group.

In the second scenario, it is demonstrated how two users develop a new spreadsheet model in a distributed session, repeatedly switching between synchronous and asynchronous cooperation. The initial layout is designed in a tightly coupled session. Then data are entered into the sheet in parallel. After the data entries have been merged, they are checked for correctness in parallel and again the corrections are merged. Finally, some formulas are entered and the derived values are discussed and analyzed in close cooperation.

In this scenario the cooperation between users with different levels of programming skill is also demonstrated: While entering formulas, the two users ask a remote expert to demonstrate how to replicate formulas by copy and paste operations. Later they replay the demonstrated commands using the interaction recorder to completely understand all details of the solution.

CONCLUSIONS

A general, application-independent history mechanism based on command objects is demonstrated. It has been generically implemented in the GINA application framework and thus been introduced into a number of non-trivial applications with state-of-the-art direct-manipulation user interfaces. The demonstration shows that our object-oriented representation of the dialog history as an integral, persistent part of the document state enables a number of improvements of the user interface for both single and multi-user applications:

- A selective undo/redo of arbitrary, isolated commands is possible, which is especially important for multi-user applications.

- An animated replay of the dialog history can serve as a help facility. In a distributed shared session an expert can demonstrate the necessary interactions to solve a problem, and a novice can later replay and analyze the solution.

- A smooth transition between synchronous and asynchronous cooperation is possible. Separately edited versions of a document can later be merged, because all modifications leading away from the common state are available as different branches of the dialog history.

FUTURE WORK

The benefits of the proposed mechanism have been proven but the optimal user interface is still an open question. Without a better visualization of the history tree end users cannot exploit the full power of the concept. There must be special support for users negotiating which of the asynchronously performed modifications to a document will be retained. Special care has to be taken to visualize and animate the commands performed by other users in order to make them understandable. The different levels of coupling between users will be integrated with the virtual room system. For example, leaving a room carrying a document means to switch the session to decoupled mode.

ACKNOWLEDGEMENTS

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	Year of Publication: 1993
	ISBN:0-89791-575-5

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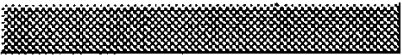
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Year of Publication: 1993
ISBN:0-89791-575-5

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